REMARKS

Claim 30 has been amended to clarify the claim, and to address the rejection of claims 30-38 under 35 U.S.C. § 112, first paragraph. Support may be found, for example, on page 5, lines 3-10 of the specification. No new matter has been added.

Turning to the Examiner's rejection of claims 1-4, 6-27, 29, 33, 35-37, 39, and 64-71 under 35 USC § 112, first paragraph, the Examiner continues to reject the claims as containing subject matter that was not described in the specification in such a way as to enable one skilled in the art to which it pertains, or with which it is most nearly connected, to make and/or use the invention. Specifically, the Examiner has concluded under *In re Wands* that the claimed invention could not be practiced by one having skill in the art without "undue experimentation." The Examiner states:

> "The specification presents guidance to utilize microfluidic devices and electrophoretic devices to move DNA molecules without providing guidance to be able to determine where an individual molecule is with the precision required to execute memory write and read operations on an individual molecule. The specification does not provide specific guidance regarding how data is to be processed for encoding into the sequences of DNA molecules, nor does the specification provide guidance regarding how DNA sequences of individual molecules are to be processed to regenerate stored data." (Final Rejection page 3).

Applicants respectfully traverse the Examiner's rejection. First, the Examiner has misconstrued the Applicants' invention. While methods are described that would allow for reading and writing of individual bases or components of a larger macromolecule, the claims are drawn to:

> "a write head that encodes strands of molecular material with sequences of binary data; a storage block for storing the strands; a read head for reading out a sequence of binary data from a selected strand; and a transport mechanism that selectively moves the strands between the write head and the storage block, or in response to a read command, between the storage dock and the read head, and then to a dump or back to the storage block." (See independent Claim 1)

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These steps involve physical properties involving physical manipulations. As the Applicants note in the specification, (Page 23) Gene Chips were known in the art. See e.g. W.W. Gibbs, "Shrinking to Enormity" *Scientific American* pp 33-34, February, 2001. (See Exhibit A).

Further, consistent with independent Claim 1, binary data may be stored on molecular material without that data being made up of a single base. The specification describes that the data may be "individual bases or collections of bases" depending on the precision of the instruments. (page 8, 9). For example, an individual DNA base may be used and assigned a binary value (C=00, G=01, A=10 T=11 or some equivalent), or a string of bases may be used (CCCCCCCCCC=00, GGGGGGGGGG=01 etc...). Reading and writing such sequences are well within the skill of those in the art. The Examiner states that there is no guidance in the specification to use more than 2 bases per datum, and that the applicants do not show evidence that alpha hemolysin nanopores can resolve two base units. (Final rejection page 7). Applicants respectfully submit that one having skill in the art would recognize that a description of a "collection of bases" as contained in the specification cited above teaches that multiple, even hundreds, of bases may be used to encode a single binary datum. Moreover, the specification teaches that a collection of bases may be used "depending on the precision of the read head." (Page 9) One having skill in the art would certainly recognize that the collection of bases used must be sufficient to be read by a given read-head.

The Examiner goes on to explain,

> The specification provides guidance to synthesize the individual molecules to comprise a desired sequence on page 19-33. Write mechanism 1 requires in situ chemical synthesis. In situ synthesis is a time consuming and complicated procedure and the specification does not show how such a procedure is

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> compatible with a read-write memory storage apparatus that functions with a practical time period. (Final Rejection at Pages 3-4)

The Examiner further states that the applicants have not described whether the "the level of errors present would make error correction mechanisms impractical." (Final Rejection P. 7) And, the Examiner later states that "the applicants arguments are not persuasive in the absence of evidence that the prophetic mechanisms described in the specification are practical."

The Examiner misapplies the standard of 35 USC § 112. As § 2164 of the MPEP makes clear,

> The information contained in the disclosure of an application must be sufficient to inform those skilled in the relevant art how to both make and use the claimed invention. However, to comply with 35 U.S.C. 112, first paragraph, it is not necessary to "enable one of ordinary skill in the art to make and use a perfected, commercially viable embodiment absent a claim limitation to that effect." *CFMT, Inc. v. Yieldup Int'l Corp.*, 349 F.3d 1333, 1338, 68 USPQ2d 1940, 1944 (Fed. Cir. 2003) (an invention directed to a general system to improve the cleaning process for semiconductor wafers was enabled by a disclosure showing improvements in the overall system). Detailed procedures for making and using the invention may not be necessary if the description of the invention itself is sufficient to permit those skilled in the art to make and use the invention. (emphasis added)

In this case, even if in situ synthesis is time consuming, it is a practice that is well known in the art, and one having skill in the art would be enabled to make and use the claimed invention. The fact that a synthesis may be "time consuming" per se is not a basis for rejecting a claim under 35 USC § 112. Applicants submit one being skilled in the art would be able to practice the claimed invention using in situ synthesis without undue experimentation. The time required to write a data source under this method is irrelevant. Furthermore, as the specification states, "a storage device can be configured with multiple read/write stations to access one or more blocks of parking lots to provide parallel read/write capability to reduce access time and increase throughput." (Specification Page 38, lines 21-25) Using multiple, perhaps thousands,

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of parallel write stations, the synthesis of a macromolecule containing digital data may be achieved quickly and efficiently. The Examiner posits in the Final Action that "the amount of time required to use the claimed device is relevant to consider the degree of difficulty and amount of experimentation required as a factor when assessing whether using the claimed device would require undue experimentation." However, applicants do not see how the relatively slow write time of write mechanism 1 would lead to undue experimentation in using the claimed invention.

The Examiner goes on to state:

> "Write mechanism 2 requires that individual nucleotides are added to a chamber containing the growing chain and a polymerase, but the specification does not address how to prevent errors due to inlet of more than one nucleotide, or how a polymerase incorporates a single substrate molecule with perfect efficiency even though enzymes generally require minimum concentrations of substrates to function." (Final Action at page 4)

This is inaccurate. First, the specification describes error correction coding of the same type that is presently used in all data storage and communication systems. Namely, by adding error-correction bits to the data bits, one can always correct errors that arise either during the write process or during the read process (or both). (Specification page 14 lines 14-18). The specification also describes storing any information as a palindromic sequence or as a double strand to prevent transcription errors. (*see* pages 12-13). Further, the specification states:

> [T]he enzymes needed for the base insertion chemistry could be attached to the α-hemolysin proteins via a long tether, which would hold them in close proximity to the pore while, at the same time, prevent the enzyme and the pore from interfering with each other's activity. The chemistry would then proceed more rapidly as the kinetics would no longer be limited by the diffusion rates of the enzymes and the DNA molecule. The chemistry would be further accelerated if the bases being added could be delivered in the vicinity of the localization site. (Specification page 23, lines 6-15)

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As stated, the tether allows more rapid kinetics of the enzyme and the base without interfering with activity. The tether would also allow enzymes to work at a lower concentration than those required by enzymes generally in a free fluid medium. Efficiency may also be improved by delivering the base in the vicinity of the site. Further, as stated above, the addition of bases need not be in single units. A series of bases may be used to encode a single binary datum. Again, 35 U.S.C. § 112 paragraph 1 does not require the Applicants to prove the viability or practicality of the claimed invention, but must provide enough information to allow one having skill in the art to make and use the invention. Accordingly, the specification is sufficiently clear to allow one having skill in the art to practice the described mechanism.

Turning to the reading mechanisms, the Examiner states:

> "Read mechanisms 1 and 2 require use of a nanopore or atomic force microscopy without providing specific guidance as to the nanopore or the parameters that can be measured to sequence through a nanopore or atomic force device. The specification provides guidance to use optical tweezers to move individual molecules form one part of the apparatus to another.
>
> Rhee et al., published 4 years after the effective filing date of the instant application, shows that nanopore sequencing is a promising idea that has not yet been reduced to practice. Among the practical problems to nanopore sequencing that Rhee et al. notes are that alphahemolysin pores and other nanopores used allow for discrimination of some sized of single stranded DNA, but do not allow for sequencing." (Final Action at pages 4-5)

As the Examiner notes, Rhee et al. describe that alpha-hemolysin nanopores allow for discrimination of some DNA but do not allow for sequencing. Rhee et al. state that none of the alpha-hemolysin pore technologies have achieved "single base resolution." (Rhee et al. abstract) The current specification addresses this concern in two ways. First, multiple bases may be used to encode a single binary datum making single base resolution unnecessary. Second, the specification describes manufacturing solid-state synthetic nanotubes using, for example, Argon ions. This nanopore may be significantly thinner than an alpha-hemolysin

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nanopore, improving signal to noise ratio. The Examiner states that Rhee et al. does not show success in sequencing polynucleotides using synthetic nanopores, but neither does Rhee et al. suggest that such sequencing is not possible. Rhee et al. is limited in its review to work with alpha-hemolysin nanopores. The teachings found in the specification thus allows one having skill in the art to practice the claimed invention.

In the Action, the Examiner raises the question of accuracy of the read/write process, seemingly believing that every single base must be written and read correctly for the entire process to work. This is not necessary, however, as the macro-molecular storage system allows for error correction coding of the same type that is presently used in all data storage and communication systems. By adding error-correction bits to the data bits, one can always correct errors that arise either during the write process or during the read process (or both).

In summary, each of the methods used to practice the claimed invention is described sufficiently to allow one having skill in the art to practice the invention without undue experimentation. While the Examiner may not be convinced of the practicality of the claimed invention, this is not sufficient to sustain a rejection under 35 USC § 112. Since the claimed invention is described in the specification and in the art in existence at the time of the initial disclosure, the rejection based on 35 USC § 112 is improper.

Turning to the art rejections, and considering the rejection of claims 30-32, 34, and 38 under 35 USC § 102(b) as being anticipated by Lagally et al., the reference does not describe, teach, or suggest strands of molecular material encoded with data that has been translated into a sequence of binary data in liquid-filled canals and selectively movable therein between different locations on a substrate in response to an external command as required by independent claim 30. DNA is composed of 4 distinct base pairs. It cannot be said that the

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DNA is encoded with binary data unless the base pairs have been assigned a binary value. Lagally et al. does nothing to describe a molecular material that is encoded with a sequence of binary data. Because Lagally et al. does not teach all of the restrictions of the amended claims, the rejection is improper.

In view of the foregoing amendment and comments, it is believed that all of the presently pending claims are allowable over the art.

The foregoing amendment makes no claim changes that would require further search by the Examiner. Thus, entry of the foregoing amendment and early and favorable action is respectfully requested.

In the event there are any fee deficiencies or additional fees are payable, please charge them (or credit any overpayment) to our Deposit Account Number 08-1391.

Respectfully submitted,

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I hereby certify that this correspondence is being deposited with the United States Patent Office via the electronic filing procedure on March 4, 2009.

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